Logging Utilization—
New Mexico, 1987

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RESEARCH SUMMARY

A study in 1987 on timber harvesting operations in New
Mexico resulted in estimates of logging residue, noninven-
tory product volume, and removals associated with harvest-
ing. Results show: factors that can be applied to product
volumes to estimate removals, noninventory product volume,
logging residue from product trees, and logging residue from
nonproduct trees; the number and volume of trees by diame-
ter at breast height class removed from growing-stock inven-
tories per thousand cubic feet of product volume; the volume
of residue in pieces 6 feet and longer to a 4-inch top as a
proportion of product volume; and board-foot/cubic-foot
conversion factors. This report also covers survey methods
and data reliability.

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INTRODUCTION

The Forest Survey Unit of the Intermountain Research Station inventoried the non-National Forest lands in New Mexico in 1986 and 1987 to estimate and describe the volume, growth, and mortality of the forests' trees. Timber product output (McLain 1989b), fuelwood harvest (McLain 1989a), and logging utilization studies were conducted concurrently with that inventory. The first two studies, timber product output and fuelwood harvest, provided estimates of log volumes harvested and delivered to primary wood processors such as sawmills and house log plants, and residences burning wood. The logging utilization study provided the factors to convert these harvest estimates to estimates of removals associated with harvesting. These removals estimates, when compared to inventory volumes and growth, are used to estimate the residual inventory and rate of inventory change associated with harvesting. The factors themselves provide a means to analyze the components of removals and, when compared to those developed in previous years, to ascertain changes in logging utilization practices.

This bulletin reports the results of the logging utilization study conducted in New Mexico, its use, and the study methods. The report presents factors to apply to harvest estimates to obtain estimates of removals, logging residue, diameter class distribution of the harvest, and the volume of residue in pieces 6 feet and longer.

The bulletin illustrates the factor formulas and the application of the factors and presents the derived estimates of logging residue, noninventory product volume, and removals associated with the 1986 timber harvest in New Mexico.

Cubic-foot/board-foot conversions for both International ¼-inch and Scribner rules are also included.

STUDY METHODS

The study was conducted in New Mexico using the sampling and measurement techniques designed by A. K. Wilson of the Forest Survey Project at the Intermountain Station in 1959-60.

Sample Size and Distribution

Measurements were obtained on active sawlog and multiproduct logging operations, located on timberland visited in the summer of 1987. These operations—the basic sample units—were distributed throughout the State and were selected within four strata defined by land ownership and operator size class. Two ownership classes were used—National Forest and other. Operator size

class corresponded to the production class of the wood processing plant receiving the logs harvested. Two size classes were used—small or those consuming less than 10 MM board feet per year, and large or those consuming 10 MM board feet and more per year.

Sample size was calculated to achieve a standard error of the logging residue ratio (total net cubic foot volume of logging residue divided by the total net volume of timber products) of not more than ±20 percent.

The samples were distributed throughout the strata in proportion to the estimated harvest volume occurring in each stratum. It was estimated that measurements from 20 logging operations would provide sufficient sample data to achieve a standard error of the ratio of within 20 percent. Further, it was estimated that "large" mills received about 75 percent of the timber production and that 60 percent of the harvest occurred on National Forests. In planning, the 20 samples were distributed as close to these estimates as possible. However, because of time contraints, only 17 logging operations were measured. Also, upon compilation of the timber production data, we discovered that the estimated harvest from National Forest lands in New Mexico in 1987 was about 84 percent rather than 60 percent. Of the 17 logging operations measured, 10 were on National Forest lands and 13 were at operations sending logs to large mills (table 1).

Data Collection

The study design prescribed four basic measurements to be obtained from each sample unit to meet the primary objectives of computing removals and logging residue factors.

On each sample unit 12 to 22 felled and bucked product trees, with an average sample unit total of about 4,200

Table 1—Number of logging operations measured in each stratum, New Mexico, 1987

Stratum	Owner group		
	National Forest	Other	
	- - - - Number of operations measured - - - -		
Mill size:			
Small	2	2	4
Large	8	5	13
Total	10	7	17

board feet (International ¼-inch rule) gross volume, and a varying number of associated nonproduct trees were measured to obtain:
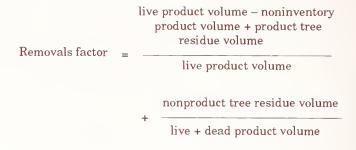
1. Product volume
2. Noninventory volume in products
3. Volume of logging residue from product trees
4. Volume of logging residue from nonproduct trees.

All measured trees were categorized as poletimber, sawtimber, salvable dead, cull, or nontimber. Both gross and net volumes in cubic feet and board feet (International ¼-inch rule and Scribner rule) were obtained by scaling. These measurements were related to obtain factors to apply to reported product volumes received by primary wood processors. Thus, all factors were calculated as proportions of product volume. No product volume from dead trees, cull trees, or nontimber species was encountered on the logging operations measured.

Factor Formulas

$$\text{Logging residue factor} = \frac{\text{product tree residue volume}}{\text{live product volume}}$$

$$+ \frac{\text{nonproduct tree residue volume}}{\text{live + dead product volume}^1}$$

$$\text{Product tree residue factor} = \frac{\text{product tree residue volume}}{\text{live product volume}}$$

$$\text{Nonproduct tree residue factor} = \frac{\text{nonproduct tree residue volume}}{\text{live + dead product volume}}$$

$$\text{Noninventory product volume factor} = \frac{\text{noninventory product volume}}{\text{live product volume}}$$

$$\text{Inventory product volume factor} = \frac{\text{inventory product volume}}{\text{live product volume}}$$

or

$$\text{Inventory product volume factor} = 1 - \text{noninventory product volume factor}$$

[1] All 266 product trees measured on the 17 logging operations in the New Mexico sample were live trees. No product volume from salvable dead trees was encountered. Because, in this case, dead product volume equals zero, the denominators of all the factors could read "live product volume" or merely "product volume."

$$\text{Removals factor} = \frac{\text{live product volume} - \text{noninventory product volume} + \text{product tree residue volume}}{\text{live product volume}}$$

$$+ \frac{\text{nonproduct tree residue volume}}{\text{live + dead product volume}}$$

STUDY RESULTS

The factors in table 2 were used to derive the growing-stock and sawtimber removals estimates presented in table 3.

Sawlog and Other Industrial Estimates

Primary wood processors provided annual estimates of the total sawlog and other industrial timber product volumes received at their plants in 1986 (McLain 1989b) and estimates of the proportion of that volume cut from dead trees. The volume from dead trees, exhibited in the "Salvable dead" column of table 3, was subtracted from the timber product volume. The appropriate factors in table 2 were applied to the remainder ("Live" column, table 3) to obtain the estimates of product volume from growing stock and sawtimber, the product volume from noninventory material in product trees, and the growing-stock and sawtimber volumes left as logging residue (product tree residue, and nonproduct tree residue resulting from the harvest of live product trees).

Additionally, the nonproduct tree residue factor was applied to the salvable dead product volumes to obtain the growing-stock and sawtimber volumes of nonproduct trees destroyed and killed while logging the salvable dead trees.

Table 2—Logging residue, noninventory product volume, and removals factors in cubic and board feet, New Mexico, 1987

Type of factor	Cubic feet	b.f.S.[1]	b.f.I.[2]
Logging residue	0.043	0.009	0.008
Product tree residue	.033	.009	.008
Nonproduct tree residue	.010	0	0
Noninventory product volume	.004	.009	.010
Inventory product volume	.996	.991	.990
Growing-stock (cubic) or sawtimber (bd ft) removals	1.039	1.000	.998

[1] Board feet, Scribner rule.
[2] Board feet, International ¼-inch rule.

Table 3—Timber production and timber removals by source of material and product, New Mexico, 1986

Products and additional removals	Product volume[1]				Noninventory product volume	Growing-stock removals
	Total	Live	Salvable dead	Other[2] sources		
	- M cubic feet -					
Sawlogs[3]	27,844	27,507	337	—	110	27,397
Other industrial[3]	2,251	2,159	92	—	9	2,150
Total	30,095	29,666	429	—	119	29,547
Fuelwood[4]	15,445	399	4,073	10,973	2	397
Logging Residue	—	—	—	—	—	[5]1,280
Total	45,540	30,065	4,502	10,973	121	31,224

						Sawtimber removals
	- M board feet (Scribner) -					
Sawlogs[3]	154,065	152,201	1,864	—	1,370	150,831
Other industrial[3]	12,137	11,627	510	—	105	11,522
Total	166,202	163,828	2,374	—	1,475	162,353
Fuelwood[6]	28,446	2,538	25,908	—	23	2,515
Logging residue	—	—	—	—	—	1,474
Total	194,648	166,366	28,282	—	1,498	166,342
	- M board feet (International 1/4-inch) -					
Sawlogs[3]	171,319	169,246	2,073	—	1,692	167,554
Other industrial[3]	13,496	12,929	567	—	129	12,800
Total	184,815	182,175	2,640	—	1,821	180,354
Fuelwood[7]	31,632	2,822	28,810	—	28	2,794
Logging residue	—	—	—	—	—	1,457
Total	216,447	184,997	31,450	—	1,849	184,605

[1]Sawlogs and other industrial roundwood volumes (McLain 1989a). Fuelwood volume (McLain 1989b).
[2]No board feet in other sources.
[3]Cubic/board foot conversions for sawlogs and other industrial roundwood are from logging residue study (table 7).
[4]Fuelwood originally reported in cords. Cords converted to cubic feet at rate of 78.6 ft³ per cord (standard conversion rate used in Arizona and New Mexico by the USDA Forest Service).
[5]Residue factors applied to sawlogs and other industrial roundwood. Not applied to fuelwood.
[6]Fuelwood conversion - from standard conversion rate used in Arizona and New Mexico by the USDA Forest Service: 2 cords = 1 M bd ft (Scribner) or 1 ft³ = 6.361 bd ft (Scribner).
[7]Fuelwood conversion - from logging residue study (table 7): 1 bd ft (Scribner) = 1.112 bd ft (International 1/4-inch).

Fuelwood Estimates

Because the logging utilization data were not collected from fuelwood harvesting operations, some adjustments were made to estimate removals from growing stock and sawtimber associated with fuelwood harvesting. Noninventory product volume factors were applied to fuelwood live product estimates, but logging residue factors were not. An assumption was that all the growing-stock volume in trees cut for fuelwood and in trees killed by such logging went into fuelwood, hence, no logging residue, and the fuelwood volume probably contained noninventory volume. For lack of anything else, we used the noninventory volume factors, developed from data collected on sawlog and other roundwood harvesting operations.

Use of Factors

The following illustrates the applications of the factors (table 2) to obtain a detailed analysis of noninventory product volume and the components of growing-stock removals (M cubic feet; table 3).

Growing-stock removals estimates:

From products:

Live product volume x inventory
    product volume factor +
Live fuelwood volume x inventory
    product volume factor   =   Total growing-stock removals from products (TGSRP)

From logging residue:

Live product volume x logging
    residue factor +
Dead product volume x nonproduct
    tree residue factor   =   Total growing-stock removals from logging residue (TGSRLR)

Removals from growing-stock = TGSRP + TGSRLR

or:

From products:

29,666 x 0.996	=	29,547	
399 x 0.996	=	397	

Total growing-stock removals from products (TGSRP)   =   29,944

From logging residue:

29,666 x 0.043	=	1,276	
429 x 0.010	=	4	

Total growing-stock removals from logging residue (TGSRLR)   =   1,280

Total removals from growing stock   =   31,224

Estimate of noninventory product volume harvested:
    Live product volume x noninventory product volume factor +

    Live fuelwood volume x noninventory product volume factor =

Noninventory product volume harvested

29,666 x 0.004	=	119
399 x 0.004	=	2

Noninventory product volume harvested =   121

Alternative

To estimate total removals only, the following procedure could be used:

From products and logging residue (live sawlog and other)

Live product volume x removals factor +

From logging residue (dead sawlog and other)

Dead product volume x non-
    product tree residue factor +

From products (live fuelwood)

Live fuelwood volume x inventory
    product volume factor   =   Growing stock removals or:

From products and logging residue

29,666 x 1.039   =   30,823

From logging residue

429 x 0.010   =   4

From products

399 x 0.996   =   397

Growing stock removals   =   31,224

Product Volume From Other Sources

Estimates of product volume cut from nonforest land and nontimber species, labeled "Other sources" in table 3, were obtained in the same manner as the salvable dead estimates. They came directly from the wood processors and fuelwood harvesters, not by application of factors to reported product volumes. Table 3 shows that fuelwood was the only product derived in any measurable volume from other sources.

Discussion of Factors

The growing-stock removals factor exceeds 1 (table 2). This means that residue exceeded noninventory product volume. This is easily confirmed by comparing the residue factor with the noninventory product volume factor. In most instances, the top logs were bucked below a 4-inch top diameter outside bark (d.o.b.), often at 7 or 6 inches, or even less frequently at 5 inches d.o.b. The wood in the upper stems between the 7-, 6-, or 5-inch top d.o.b. and the 4-inch top d.o.b. is left in the woods as residue.

This residue is a removal from inventory, not reflected in product volume.

The sawtimber removals factors are slightly less than 1 (International 1/4-inch) or equal to 1 (Scribner), indicating that noninventory product volume equals or slightly exceeds residue volume. This is due to bucking the top logs near or above the 7-inch top d.o.b. and harvesting poletimber size trees. The resulting product volume from poletimber is not board-foot volume removed from the sawtimber inventory; in other words, it is not sawtimber removals by Forest Survey standards. It is, however, cubic-foot growing-stock removals.

Table 4 exhibits the New Mexico removals factors from data collected in 1968 (Setzer and others 1970) compared to that collected in 1987. Current factors are 0.083 and 0.061 less than those of 1968, indicating less residue now than then.

LOGGING RESIDUE VOLUME IN PIECES 6 FEET AND LONGER

Table 5 contains the cubic volume of product tree residue in sound pieces ≥6 feet in length to a 4-inch top, the factors used to derive the volume estimates, and the proportion of product trees that produced residue ≥6 feet in length to a 4-inch top. The factors were derived from the logging utilization data by dividing the product tree residue volume in pieces ≥6 feet in length to a 4-inch top by the product volume from live trees. The factors are merely the residue volume expressed as a proportion of product volume. Multiplying the factors by the product volume from live timber trees reported by wood processors produces an estimate of residue volume in sound pieces ≥6 feet. Additional residue volume in pieces 6 feet and longer is often available from nonproduct trees damaged or killed by felling or skidding.

The proportion of trees measured that produced residue in pieces 6 feet and longer may be indicative of the degree of utilization. The lower the proportion, the higher the utilization.

Table 4—Removal factors by Forest Survey standards to estimate total net removals from inventory due to logging, New Mexico, 1987, compared to factors computed in 1968

Factor	1968[1]	1987	Difference
Growing-stock removals (cubic)	1.122	1.039	(−0.083)
Sawtimber removals (bd ft)	1.061	1.000	(−.061)

[1]Setzer and others 1970.

Table 5—Volume of, proportion of harvest volume (factor) in, and proportion of product trees containing logging residue to a 4-inch top in pieces 6 feet and longer, New Mexico, 1986

Residue volume in pieces 6 feet and longer (MCF)	Factor[1] for residue volume in pieces 6 feet and longer	Proportion of product trees producing residue volume in pieces 6 feet and longer
821	0.027	0.699

[1]Apply to product volume.

5

DIAMETER CLASS DISTRIBUTION OF TREES HARVESTED OR DAMAGED

Information about the number of growing-stock trees harvested or destroyed and, therefore, removed from the inventory in each diameter class and their associated volumes is useful for computing diameter class cutting rates, which in turn are useful for projecting residual inventory, growth, and yield. Logging utilization data provide an estimate of the distribution of trees removed in relation to the volume of logs harvested. Table 6 presents the total number and volume of product and nonproduct growing-stock trees removed per thousand cubic feet of product volume from live trees. These diameter distributions, which are statewide averages, may be applied to reported harvest volumes to determine removals by diameter class or be compared to previous years to determine change.

PRODUCT VOLUME CONVERSIONS

The conversion factors in table 7 were estimated from logging utilization data derived from measurements obtained on the sawlog and multiproduct harvesting operations composing the sample for New Mexico. They are thus statewide averages, reflecting average conversion for the harvest of the product mix encountered on the samples measured. Caution is recommended in applying these factors to State subdivisions or to harvests of a narrow range of products of small size, such as posts or fuelwood, or sawlogs of exceptionally large diameters (see table 6).

Table 6—Diameter at breast height (d.b.h.) class distribution of the number and volume of growing-stock trees removed from inventory through harvesting per MCF of net product volume, New Mexico, 1987—the number of trees removed in 1968 provided for comparison. The 1968 volume by d.b.h. class is unavailable

D.b.h. class	Number of growing-stock trees		Volume of growing-stock trees in cubic feet
	1968[1]	1987	1987
2	33.01	1.98	—
4	20.84	2.07	0.77
6	4.62	1.55	3.01
8	1.78	1.29	7.75
10	.73	2.50	26.78
12	.42	3.87	66.72
14	1.26	3.96	92.64
16	.73	3.96	138.01
18	1.63	2.41	102.71
20	1.47	1.64	96.68
22	1.00	1.03	79.04
24	1.31	1.46	144.47
26	.63	.77	91.78
28	1.10	.43	49.16
30+	2.05	.69	140.59
All classes	72.59	29.62	1,040.12

[1]Setzer and others 1970.

Table 7—Product volume conversion factors for New Mexico

1 cubic foot equals	5.5329	board feet (Scribner)
1 cubic foot equals	6.1546	board feet (International 1/4-inch)
1 board foot equals (Scribner)	1.1124	board feet (International 1/4-inch)

RELIABILITY OF ESTIMATES

The computation of the standard error of the various residue and utilization percentages employs the formula for the standard error of a ratio (Wilson 1965), which may be stated:

$$Sr = \sqrt{\frac{\bar{r}^2}{n}\left[\frac{\Sigma(yi-\bar{y})^2}{(n-1)\bar{y}^2} + \frac{\Sigma(xi-\bar{x})^2}{(n-1)\bar{x}^2} - \frac{2\,\Sigma(xi-\bar{x})(yi-\bar{y})}{(n-1)\bar{y}\bar{x}}\right]}$$

where

y = logging residue measured on an operation (net volume)

x = timber products measured on an operation (net volume)

$\bar{r} = \dfrac{\Sigma y}{\Sigma x}$ = logging residue ratio

n = total number of operations sampled

$\bar{y} = \dfrac{\Sigma y}{n}$

$\bar{x} = \dfrac{\Sigma x}{n}$

Sy^2 = variance for y = $\dfrac{\Sigma(yi-\bar{y})^2}{n-1}$

Sx^2 = variance for x = $\dfrac{\Sigma(xi-\bar{x})^2}{n-1}$

Cov.(yx) = covariance of y and x = $\dfrac{\Sigma(y-\bar{y})(x-\bar{x})}{n-1}$

$S\bar{r}^2$ = variance for $\bar{r} = \dfrac{\bar{r}^2}{n}\left[\dfrac{Sy^2}{\bar{y}} + \dfrac{Sx^2}{\bar{x}} - \dfrac{2\,\text{Cov.}(yx)}{\bar{y}\bar{x}}\right]$

$Sr = \sqrt{S\bar{r}^2}$ = standard error of the ratio ($\bar{r}$)

SE(%) $= \dfrac{Sr}{\bar{r}} \times 100$ = standard error of the ratio as a percentage of the ratio.

Table 8 gives the achieved standard errors of the logging residue volume/product volume ratios and the standard errors as percentages of the ratios.

TERMINOLOGY

Cubic-foot/board-foot conversions—The cubic-foot volume in product logs compared to the board-foot volume in the same logs.

Cull tree—A live timber species tree that is less than one-third sound or does not contain a merchantable 8-foot bolt (poletimber size tree) or a 12-foot sawlog in the butt log (sawtimber size tree).

Dead product volume—Same as salvable dead volume. The cubic volume in dead poletimber-size and sawtimber-size trees of timber species from a 1-foot stump to a minimum 4-inch top d.o.b.. The board-foot volume in dead sawtimber-size trees of timber species between a 1-foot-high stump and a 7-inch d.o.b. top (softwoods) or 9-inch d.o.b. top (hardwoods).

Forest lands—Lands at least 10 percent stocked by forest trees of any size, including lands that formerly had such tree cover and that will be naturally or artificially regenerated. The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width at least 120 feet wide to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if less than 120 feet wide.

Forest trees—Woody plants having a well-developed stem or stems, usually more than 12 feet in height at maturity, with a generally well-defined crown.

Growing-stock product volume—The growing-stock volume in timber products such as sawlogs, posts, poles, pulpwood, fuelwood, and house logs.

Growing-stock removals (in this publication)—The growing-stock volume removed from inventory by harvesting. Consists of logging residue and the growing-stock volume of products.

Growing-stock trees (in this publication)—Live sawtimber trees and poletimber trees meeting specified standards of quality and vigor; excludes cull trees.

Growing-stock volume—Net cubic-foot volume in live poletimber-size and sawtimber-size growing-stock trees from a 1-foot stump to a minimum 4-inch top (of central stem) outside bark or to the point where the central stem breaks into limbs.

Industrial wood products—All timber products except fuelwood.

Inventory product volume—The growing-stock or sawtimber volume in timber products.

Live product volume—Product volume minus salvable dead and other sources.

Table 8—Achieved standard errors of the logging residue volume/product volume ratios and the standard errors as percentages of the ratios

	Sr	SE(%)
Cubic foot	0.0071	16.45
Board foot, Scribner	.0025	27.17
Board foot, International 1/4-inch	.0022	27.05

Logging residue—The unused growing-stock or sawtimber volume of trees cut or killed by logging and left in the woods.

M—Thousand

Mbf—Thousand board feet

MCF—Thousand cubic feet

MM—Million

Noninventory product volume—The cubic volume of timber products that came from the upper stems (beyond the 4-inch top d.o.b.) or below the 1-foot high stumps of growing-stock product trees; the board-foot volume in timber products that came from poletimber trees and below the 1-foot high stump of sawtimber trees; the product volume of cull trees.

Non-National Forest lands—Lands not administered by the Forest Service, U.S. Department of Agriculture.

Nonproduct tree residue—The growing-stock or sawtimber volume of nonproduct trees cut, killed, or damaged while felling or skidding product trees. This volume is left in the woods. It is a component of slash.

Nonproduct trees—Those trees cut, killed, knocked down, or destroyed due to felling and skidding the product trees.

Nontimber tree—Other than timber species.

Other sources—Product volume from nontimber species (such as juniper and, in the West, oak) and trees harvested on nonforest land (such as urban streets, orchards, and windbreaks).

Poletimber tree—A live tree of timber species, at least 5 inches diameter at breast height (d.b.h.) but smaller than sawtimber size, containing at least one 8-foot bolt, and more than one-third sound.

Primary wood processors—Mills, plants, and yards receiving logs for processing into such products as studs, boards, lumber, fiberboard, plywood, utility and building poles, house logs, excelsior, pulp and paper, pulp chips, mine timbers, railroad ties, pilings, hop stakes, grape stakes, barrel staves, siding, paneling, and shakes. Primary wood processors include sawmills, fiberboard mills, plywood plants, house log plants, post and pole yards, post and pole treating plants, excelsior manufacturing plants, and pulp and paper mills.

Product tree residue—The unused growing-stock or sawtimber volume of product trees that is left in the woods.

Product trees—Those trees selected for harvest. Trees felled for products such as sawlogs, posts, poles, pulpwood, fuelwood, or house logs.

Product volume—The cubic-foot or board-foot volume in timber products such as sawlogs, posts, poles, pulpwood, fuelwood, and house logs. Product volume comprises volume from salvable dead trees, other sources, and the noninventory and growing-stock (or sawtimber) volume from growing-stock trees.

Removals (in this publication)—The growing-stock and sawtimber volume removed from the inventory by harvesting. Consists of logging residue and the growing-stock and sawtimber volume of products.

Residual inventory (in this publication)—The growing-stock and sawtimber volume remaining after the inventory is reduced through removals due to harvest.

Salvable dead trees—Standing or down dead trees of timber species that are merchantable by regional standards.

Salvable dead volume—The cubic volume in dead poletimber-size and sawtimber- size trees of timber species from a 1-foot stump to a minimum 4-inch top d.o.b. The board-foot volume in dead sawtimber-size trees of timber species between a 1-foot-high stump and a 7-inch d.o.b. top (softwoods) or 9-inch d.o.b. top (hardwoods).

Sawlog portion—That part of the bole of sawtimber trees between a 1-foot stump and the sawlog top.

Sawlog top—The portion on the bole of sawtimber trees above which a sawlog cannot be produced. The minimum sawlog top is 7 inches d.o.b. for softwoods and 9 inches d.o.b. for hardwoods.

Sawtimber product volume—The sawtimber volume in timber products.

Sawtimber removals (in this publication)—The sawtimber volume removed from inventory by harvesting. Consists of logging residue and the sawtimber volume of products.

Sawtimber tree—A live tree of timber species meeting regional size and defect specifications. A softwood tree must be at least 9 inches d.b.h. and a hardwood tree 11 inches d.b.h. The tree must contain at least a 12-foot sawlog in the butt log and be more than one-third sound.

Sawtimber volume—Net volume in board feet of the sawlog portion of live sawtimber trees.

Slash—The wood volume cut or killed as a result of logging and left in the woods (not hauled out as timber products). Slash consists of logging residue (growing-stock and sawtimber volume) and noninventory volume (such as tree tops, limbs, cull trees, dead trees, and nontimber trees).

Timberland—Forest land where timber species make up at least 10 percent stocking.

Timber products—Roundwood products such as sawlogs, posts, poles, pulpwood, fuelwood, veneer logs, and house logs.

Timber removals—Same as "Removals."

Timber species—Trees traditionally used for industrial wood products. In the Rocky Mountains, these include only two hardwoods, aspen and cottonwood, and all softwood species except pinyon and juniper.

Total removals (associated with harvesting)—Comprises the growing-stock (or sawtimber) volume contained in products, the product tree logging residue, and the nonproduct tree logging residue.

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Reports results of a study made on timber harvesting operations in New Mexico to derive factors used to estimate logging residue, growing-stock and sawtimber removals, diameter class distributions of harvests, and board-foot/cubic-foot conversions.

KEYWORDS: timber removals, growing-stock removals, sawtimber removals, cubic/board-foot conversions, logging residue

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

The Intermountain Research Station territory includes Montana, Idaho, Utah, Nevada, and western Wyoming. Eighty-five percent of the lands in the Station area, about 231 million acres, are classified as forest or rangeland. They include grasslands, deserts, shrublands, alpine areas, and forests. They provide fiber for forest industries, minerals and fossil fuels for energy and industrial development, water for domestic and industrial consumption, forage for livestock and wildlife, and recreation opportunities for millions of visitors.

Several Station units conduct research in additional western States, or have missions that are national or international in scope.

Station laboratories are located in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Ogden, Utah

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)